CHAPTER IV
FOREIGN TECHNOLOGY TRANSFER IN THE INDIAN TYRE INDUSTRY

The problem of transfer of technology from the developed to the developing countries have been and continues to be a matter of great interest both at national and international levels. With a view to accelerate the pace of economic development of their countries, the developing countries have always been looking to the developed countries for importing advanced technology which would help them in ameliorating the condition of their masses. Out of many industries in India, tyre industry is an illustration in this case which was previously wholly under the control of multinational giants operating on a global scale like Dunlop and Firestone. There was very little technological knowhow within the country, manufacturing technology and product pattern were based on the decisions taken by these Multinational Companies. Even though the industry has now come of an age and operating mostly under the Indian Management (except Goodyear) dependence on foreign technology still continues. Almost all the Indian tyre companies have technical collaboration with well known international tyre companies. Hence incorporation of this chapter in the thesis is of great significance. This chapter attempts to examine the concept of technology, technology transfer, technology transfer agreements, modes of acquiring technology, cost of technology, technology assimilation and adaptation. The question of why there is a continuous
CONCEPT OF TECHNOLOGY :-

The word technology denotes utilization of technical knowhow pertaining to men material and machinery. It pertains to the use of patent and trade mark, licence, plant layout and designs other production know-how, pre-investment services, problem solving services, training of personnel, drawing and specification etc. The term ‘technology’ has been interpreted by various authors in different ways.

According to Rosegger Gerhard "Technology is human knowledge applied in production or consumption - it is used knowledge". (1) Economists have defined technology as "The knowledge and the techniques with which inputs into the production process are transferred into output". (2)

Industrialists expresses the concept of technology " as the specific knowhow required to define a product that fulfills a need and then to design and manufacture it". (3)

UNIDO defines technology "as the sum of knowledge, experience and skills necessary for manufacturing a product and for establishing an enterprise for this purpose". (4)

Lionel Goldring says " Technology is knowledge more elaborately technology is any tool or technique, product or
From the above definitions, it is clear that these are describing technology as the knowledge and the ability to apply that knowledge in manufacturing product. But for the purpose of this thesis we are taking technology in the broader sense. Technology is the knowledge required for designing the plant, producing a product, enhancing productivity, improving the quality of product, imparting training for the above purposes and any other special services provided in this connection.

TECHNOLOGY TRANSFER:

When knowledge and information emanating from one source towards a specific application can be applied to similar situations in other environments with or without modifications in related or unrelated industries, it is called as transfer of technology. According to National Research Council technology transfer implies "a process linking the technology supplier to the technology user. How technology is transferred depends on the type of technology and industry, governmental regulatory restraints, the size of market, the sophistication of the user of technology, and the cost and benefit to supplier and user ".(6)

Dholakia(7) says that "the concept of technology
transfer is not capable of exact and complete definition, primarily because the word technology is incapable of precise connotation. However, the transfer of technology could involve:-

i) Communication of data relating to some area of scientific knowledge (Whether such data are patented or not)

ii) Exploitation of licence for patent

iii) Transfer of right relating to the use of such data

iv) Transfer of tangible property such as plant equipment, etc.

v) Performance of services like design or advanced engineering, consultancy, training of personnel, etc.

So far as 'Tyre Industry' is concerned, technology transfer from foreign collaborators is taking place in the area of compounding of raw materials, processing of raw materials, tyre engineering, testing of tyres produced, improvement in tyres, modernization of equipments, enhancing productivity, improving the quality of product and imparting training to the personnel of tyre companies. Fig. 4.1 also depicts the different phases/sections of the entire tyre manufacturing activity where our collaborators' technical assistance is available for on-going improvement.

MODES OF TECHNOLOGY TRANSFER:-

There are various ways through which transfer of technology from one country to another can be effected e.g. Turnkey Operations, Licensing, Foreign Direct Investment,
Areas where technical assistance from collaborators is available:

- Energy
- Modernisation
- Engineering
- Productivity
- Quality
- SPC
- Circle
- Process
- Technology
- Development
- Testing/evaluation
- Tyre engineering
- Processing
- Compounding
- Technology
- Special services
- Training
- Engineering
- Productivity
- Quality
Published Literature, Meetings and Seminars, training and education, etc. Details of these are given below:

**Turnkey operations:** In this case the technology donor constructs a fully functioning production facility for the technology recipient from the stage of conception to the stage of working of plant. In this, the recipient can have an agreement with the donor for providing training facilities to its technicians and managers for efficient running and maintenance of plant. But due to low technical knowhow the recipient is generally dependent on the donor for running and maintenance of plant.

The great inhibiting factor in this mode is the prohibitive cost involved in it. The purchase of turnkey technology generally involves an outgo of scares foreign exchange which generally fluctuates unfavourably for India. Another disadvantage is the minimum acquisition of knowhow since the recipient is buying a finished product, it may not acquire many of the engineering and management skills needed to construct the facility. Tyre companies have not opted for this mode of technology.

**Licensing:** One of the Chief Mechanism employed for transferring technology is licensing. A license is an agreement that allows the licensee to employ a donor's technology subject to certain stipulations as agreed by the parties to the agreement. Usually the recipient pays a fees or royalty to the donor for the use of technology. This
method is useful in cases where the recipient has great degree of ability to absorb the foreign technology. The terms and conditions of licensing agreements vary between donor and recipient and reflect their bargaining power. (8) This way of acquiring technology has been preferred generally by majority of tyre companies in India. The agreement generally involves the transfer of patent rights, technical knowhow and training of personnel either in India or abroad of the host country. For this service the licenclee is required to pay royalty on net sales value which is very nominal.

**Direct Foreign Investment:** A part of capital, majority or minority, technological knowhow and resources are brought into the host country by the foreign firms. In such cases, financial participation acts as a vehicle of technology transfer. The local contribution consists of providing balance capital, infrastructure facilities including skilled and unskilled manpower etc. In such cases the control of enterprise is in the hands of foreign firms which holds majority of equity shares. In case of tyre industry barring a few exception the management is in the hand of local entrepreneurs who have majority of equity holdings but have technical collaboration with foreign firms.

**Published Literature:** Published literature is one of the mechanisms for transferring scientific information. But the principal deficiency is that by the time the information is finally published it may become obsolete as there is a big time lag between the research and publication of the results.
of such research. Reviewers comments may require rewriting in the light of their suggestions which is also a time consuming process.

Meetings and Seminars:—The delay inherent in publishing scientific findings are partially compensated when scientists meet at seminars and meetings and exchange their views. A great deal of transfer of information occurs in the convention halls as compared to the information that is published in the journals. This is a better way of disseminating scientific information and knowledge in time provided funds are readily available for convening such seminars.

Centralized Purchases:—In this mode of transfer of technology an organization in a host country purchases technology on an outright basis and after adapting it suitably passes it to one or more firms in the country. In such cases large number of firms get benefits simultaneously with nominal payment. Another advantage is that the centralized organization in consultation with the collaborating firm can set up R&D institutions in the country to achieve self-reliance. But this mode of technology transfer in case of tyre companies has so far been not extended by the collaborators.

To sum up, though there are various modes of acquiring technology yet, in India, the tyre industry is obtaining the same through licencing agreement on the payment of royalty for a specific period.
CLAUSES OF COLLABORATION AGREEMENTS:

Collaboration agreements with foreign collaborators generally include the following information:

Collaborators make available all necessary detail, comprehensive engineering and other drawings, designs, layout specifications to enable company to construct/erect said plant. All these come under the heading plant know-how. In so far as technical information is concerned, it relates to:

i) consultation on the operation and maintenance of plant.

ii) collaborator will disclose to and familiarize Indian tyre companies or its representatives during their visit to locations of collaborator or its subsidiaries with latest marketing, distribution and sales promotion methods and techniques employed by the collaborator or its subsidiaries.

iii) Information relating to newly designed production equipment that is adopted for production purposes by collaborator.

iv) Technical assistance through correspondence, visits in order to solve technical problems arising at the plant. Collaboration agreement provides that collaborator will make best of their efforts during the period of collaboration agreement that the quality of tyres is not inferior to those produced by Indian manufacturers.

Collaboration agreements provide for production of specified quantity, if production falls below guaranteed quantity then royalty will be paid only on actual production produced and sold. In case of Modi Rubber, collaboration
agreement provides for the payment of licence fees for production of about 20 lakh numbers of tyres and tubes. If production exceeds this capacity then additional royalty will be paid upto 25 percent of the licensed capacity. Over and above this capacity, no royalty can be paid without the approval of government. But now, tyre industry has been delicensed hence this provision will not apply. Agreements do not state about the payment of minimum royalty.

Collaboration agreements stipulate for the payment of lumpsum as technical documentation and engineering disclosure fees. This lumpsum shall be payable in three instalments as detailed below:-

a) First 1/3rd after the agreement is filed with Reserve Bank of India (RBI) and the capital goods clearance if any, is obtained.

b) Second 1/3rd on delivery of technical documentation.

c) Third and final 1/3rd on the commencement of commercial production or four years after the agreement is taken on record whichever is earlier.

Royalty for continuous technical assistance at different rates on net sales value, after deduction of taxes is paid by Indian tyre companies to foreign collaborators. Table 4.1 gives the details of the position of technical collaboration of various tyre companies and also the latest royalty rates.
<table>
<thead>
<tr>
<th>NAME OF COMPANY</th>
<th>COLLABORATION WITH</th>
<th>DURATION</th>
<th>TERMS AND CONDITIONS</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apollo Tyres</td>
<td>General Tyres</td>
<td>(a) January 1977 to January 1982.</td>
<td>Recurring royalty @ 2% subject to tax on net sales of the first 3 lakhs numbers each of automobile tyres and to be per annum.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>International Co.</td>
<td></td>
<td>1% on balance as on tyres and tubes upto 2 lakh numbers.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(STIC)</td>
<td></td>
<td>4% on export sales subject to taxes and above the obligatory export of 10% of total production.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(b) January 1982 to January 1987.</td>
<td>Royalty @ 1.25 subject to tax on net sales of automobile tyres and tubes per annum.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4% on export sales subject to taxes and above the obligatory export to 10% of total production.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(c) January 1987 to Jan. 1992.</td>
<td>0.75% for conventional tyres and 1.25% for radial tyres.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Govt. agreed to 0.75% for conventional tyres exported and 1.25% for radial tyres.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Company has requested Govt. to agree for technical collaboration for conventional tyres supplied to domestic market also.</td>
<td></td>
</tr>
<tr>
<td>2. Bombay Tyres</td>
<td>Firestone tyres</td>
<td>(a) 1940 to June 1970</td>
<td>2.5 US Cents per Pound of production.</td>
<td></td>
</tr>
<tr>
<td>International</td>
<td>and Rubber Co.</td>
<td></td>
<td>(b) 1971 to 1981</td>
<td>NIL</td>
</tr>
<tr>
<td>Ltd. U.S.A</td>
<td></td>
<td></td>
<td>(c) Collaboration expired in 1981</td>
<td><strong>Contd....</strong></td>
</tr>
</tbody>
</table>
3. Ceat Tyres of India Ltd.  
Ceat Coma SPA, Italy. It was transferred to

(a) June 1968 to May 1968  
Lump sum – Rs. 6 lakhs

Royalty @ 3% to 2.5% on a declining sale of production as follows:

(a) 3% on the sale price of the output up to 325 tonnes of production.
(b) 2.7% up to 600 tonnes
(c) 2.5% up to 1000 tonnes

(b) May 1971 to April 1976  
Royalty @ 0.5% on net sales value of expanded production of 2.5 lakhs nos. of tyres and tubes plus extra. Later on they were also permitted to pay royalty at the same rate on additional capacity of 1.6 lakh nos. of tyres and tubes.

(c) 1984 to 1989  
Yokohama Rubber Company, Japan

0.75% on net sales value on conventional tyres and 2% on net sales value on radial tyres lumpsum payment Rs. 12 lakhs.

4. Goodyear India Ltd.  
Goodyear tyre and Rubber Co., U.S.A

1961 to August 1971  
Recurring royalty at sliding scale @ 3%.

1971 to 1976  
Royalty @ 0.5% on domestic sale and 5% on export. No royalty since 1976 for conventional tyres.

Royalty @ 2% on Radial tyres only technical know how (Rs. 12 lakh gross of tax)

5. J.K. Industries Ltd.  
General Tyres International Co. to February 1977  
(B.T.I.C.) 1982

2% on net sales of the first 3 lakh numbers each of automobile tyres and tubes per annum.

1% on balance as on tyres and tubes up to 2 lakh nos.

4% on export sales subject to taxes and above the obligatory export of 10% of total production.

Contd...
Lumpsum = $2 lakhs for initial disclosure fee and $2.5 lakhs for engineering and documentation.

3% commission purchase of Plant and Machinery.

1.25% subject to taxes on net ex-factory sales value of Bias Ply Tyres/Radial tyres and tubes

4% subject to tax on net Export Sales inclusive of Royalty computed in (i) above. This Royalty is payable only on the exports over and above 10% of total production

Royalty on conventional tyres

@ 2% on ex-factory sales value subject to Indian taxes restricted to 4 lakhs tyres up to a maximum of 25%.

Technical Documentation and other back ground engineering disclosure fee-Rs.37.875 lakhs

Royalty @ 1.25% subject to taxes on net ex-factory sales restricted to 4 lakh numbers plus 25%.

No Lumpsum payment.

Royalty @ 2.5% of net Sales on the first 1.2 lakh numbers of tyres and tubes.

2% on the next 60,000 tyres and tubes sold in a year up to 1.8 lakhs and 1.5% of net sales of the next 60,000 tyres & tubes up to 2.4 lakh nos, Each and 1% of net sales in excess of 2.4 lakh numbers of tyres and tubes.

Contd...
Purchase commission of 5% in respect of Capital goods and 3% in respect of Raw-materials, lumpsum fee of Rs.1 lakh.

April 1973 to March 1978

Royalty @ 1% subject to tax on the ex-factory value of production of the first 6.10 lakh nos each of tyres and tubes

Royalty @ 0.5% subject to tax on the production in excess of 6.10 lakh nos. but restricted to 3.9 lakh nos each of tyres and tubes

Royalty @ 0.5% subject to tax on the net ex-factory production of bias belted and radial ply tyres.

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Location</th>
<th>Years</th>
<th>Royalty Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRF (Goa factory)</td>
<td>Mansfield</td>
<td>April 1973 to March 1978</td>
<td>Lumpsum payment Rs.7.25 lakhs.</td>
</tr>
<tr>
<td>MRF (Both Goa and Madras)</td>
<td>B.F.Goodrich</td>
<td>1980 to 1985</td>
<td>Royalty @ 1.5% for Radial tyres, Royalty @ 0.75% for conventional tyres and tubes upto 18 lakhs plus 25% on extra production.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No Lumpsum payment</td>
</tr>
<tr>
<td>Uniroyal Goodrich</td>
<td>U.S.A.</td>
<td>1985 to 1990</td>
<td>Royalty @ 0.75% for bias ply-tyres and 1.5% for radial tyres</td>
</tr>
<tr>
<td>(8) Dunlop India Ltd.</td>
<td>Sumitomo Rubber Industries, Japan</td>
<td>(a) 1985 to 1986</td>
<td>0.5% of net sales</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) 1986 to 1991</td>
<td>5% of Aero tyres</td>
</tr>
<tr>
<td>(9) Vikrant Tyres Techno Exports</td>
<td>Czechoslovakia</td>
<td>(a) 1977 to 1982</td>
<td>1% of net sales</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) 1982 to 1987</td>
<td>1% of net sales</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) 1987 to 1992</td>
<td>0.25% on radial tyres, 0.25% on conventional tyres</td>
</tr>
</tbody>
</table>

as approved by the Government. Over a period of time, the rate of royalty payments has progressively reduced as is evident from this table.

Modi Rubber is paying to M/S Continental AG, West Germany in the Deutsche Mark by remittance to a bank designated by Continental for this purpose. The foreign exchange requirements to meet the above expenditure could be capital contribution from collaborators, loans from foreign financial institutions, government to government credit arrangements and loans from local financial institutions.

In the recent past foreign exchange expenditure of Modi Rubber has been met through local financial institutions. Sometimes the government feels that initial lumpsum and royalty fees claimed by collaborator is on higher side. In such case discussions are held with the company representatives on the need for paying higher money and opportunity is given to Indian company to explain the relative merits of technology it is looking for and reasons thereof for higher initial fees and royalty payments. After this discussion the government recommends the initial payment and royalty rate taking into consideration the points put forward by Indian company.

As per the collaboration agreement foreign technicians have also been deputed in Indian tyre companies. Their number, period of assistance and rate of allowances, are
approved by the Government of India. Engagement of foreign technicians by Indian firms/companies would not now need prior approval of the RBI if the terms of engagement conform to the following guidelines: (a) The total duration of engagement of foreign technicians by any firm/company does not exceed 12 man-month in a full calendar year with the duration of a single technician not exceeding three months at any one time. (b) The payment of fees and remuneration to any single foreign technician does not exceed $500 or its equivalent a day regardless of whether the local costs on boarding, loading and other items are met by the Indian firm/company or not. (c) In the case of a company to company contact where payment of fees for the service rendered by the foreign technicians is to be made to the overseas company, the total amount payable to the overseas company does not exceed $50000 or its equivalent in a full calendar year. Indian tyre companies, during the term of collaboration agreement also send its personnel to factories/plants of collaborators and they disclose all its technical information. During erection period the collaborator may depute two or three senior engineers, about ten to fifteen juniors to assist in the erection of plant and machinery, implementation of project and training of personnel. Once plant is commissioned people initially involved with the project go back and one or two technicians or engineers stay for a longer duration as approved by the government of India to monitor the plant working and
product quality. As per Mr. R. Rajamani, Technical Manager, Modi Rubber, two or three personnel from their plant go to collaborators unit in a year to hold meetings and experts from collaborator unit visit India to get acquainted with the local operations and discuss about the technical problems. The duration of their stay is usually of ten to fifteen days. Company also sends three to four personnel for training in various sections, to the collaborator's factory. Usually two people in a particular key area get training. The duration of their training period is of two to four weeks.

Collaboration agreements also stipulates that with the consent of foreign collaborator and after obtaining the approval of government of India, the Indian company can sub-license the technical know-how/production design/engineering design to another Indian company. Until now no tyre company has sub-licensed know-how imported from collaborators. As government is insisting upon this clause that is why this clause is included in the collaboration agreement. Without this clause the government does not approve the collaboration agreement. However many people who served in the multinational groups have left these companies and imparted know-how to various medium scale tyre companies. This amounts to passing on the technology from one source to another in an indirect way.

Collaboration agreements provide for testing of
products produced by company and analysis of raw material used in the manufacturing of such product. This testing is done at the expense of Indian company at collaborators laboratory whenever testing equipments are not available in India.

On the request of Indian companies collaborators also give advice about the advantageous sources of supply for the purchase of machinery and equipment. They assist in the inspection and selection of machinery on behalf of licensee. Tyre companies see that machinery bought is approved by collaborators before purchase so that quality and quantity of tyres is not affected in any way.

As majority of tyre manufacturing machines are manufactured in India. Therefore, only special and sophisticated machinery is imported. Machinery for production of radial tyre is yet to be developed in India, as such it is currently imported. Specification for equipment is fixed by the collaborator. Then tyre companies go for global tender. Tyre company sits with the collaborator and goes through the specifications quoted by the parties i.e. evaluation of tenders is done. As foreign collaborators generally have a control on suppliers, therefore, assistance is taken from them for negotiation.

Collaboration agreements also contain restriction for the use of foreign brand name for internal sales, although there is no objection to their use on products to be exported. For internal sales however, the company can use
this name with previous approval of the collaborator. For the use of trade mark no additional royalty is paid.

Collaboration agreement varies for a period of 5 to 8 years. Eight years period is permitted when new project is to be commissioned. In such a case two years are given for installation of plant, one year for commencement of production and five years for continuous production. This period is fixed by the government of India.

Collaboration agreements also stipulates that benefits of research and development undertaken by it will be provided to Indian company. As per Mr. Rajamani, Technical manager, Modi Rubber, in their case it has been provided and no additional fees has been charged for the same.

Another important clause of the collaboration agreement is that if any tyre company has purchased technology from one collaborator for a fixed period of time then during the same period it can not acquire technology from another collaborator for the same product.

**COST OF TECHNOLOGY TRANSFER** :-

Technology transfer costs are the costs of transmitting and absorbing the relevant firm knowledge. This cost is influenced by the numerous factors viz (a) the extent to which the transfer is of complete manufacturing system or a part of manufacturing system. Where the transfer is of a complete manufacturing system it might involve relatively
higher transfer cost. (b) Technology market, technological capabilities and the extent of knowledge on the part of LDC buyers also affects the technology transfer cost, as these will effect the bargaining power of LDC buyer in international technology market. If the technology is very old and there are many suppliers of technology in the market, the price may be less or vice-versa. (c) information regarding the technology / its market and domestic scientific infrastructure at institutional level also effects technology cost. If the buyer is aware of different suppliers and the market of technology, its bargaining strength will be more. If the buyer has a strong scientific base at firm level, its bargaining power will be further enhanced.

Technology transfer cost can be bifercated into two parts viz direct and indirect cost. Direct cost of technology import (TECHIM) would include the fees paid to the collaborator which may be divided into (i) royalty (ii) basic know-how package fees (iii) fees for engineering services (iv) fees for other services / assistance in equipment procurement inspection and commissioning of plant (v) profit. If technology import is through licensing the usual cost are lumpsum payments, royalty and technical fees paid abroad by the licensees. If it is through direct investment then servicing charges include remittances of profit and dividend.
Table 4.2
REMITTANCES ABROAD OF INDIAN TYRE COMPANIES

(Rs. in lakhs)

<table>
<thead>
<tr>
<th>Year</th>
<th>Dividend</th>
<th>Royalty</th>
<th>Tech. fees</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982-83</td>
<td>279.49</td>
<td>220.79</td>
<td>6.26</td>
<td>530.33</td>
</tr>
<tr>
<td>1983-84</td>
<td>169.16</td>
<td>295.47</td>
<td>42.86</td>
<td>596.88</td>
</tr>
<tr>
<td>1984-85</td>
<td>17.82</td>
<td>425.94</td>
<td>30.65</td>
<td>539.27</td>
</tr>
<tr>
<td>1985-86</td>
<td>146.69</td>
<td>469.73</td>
<td>58.08</td>
<td>767.34</td>
</tr>
<tr>
<td>1986-87</td>
<td>285.98</td>
<td>485.62</td>
<td>202.40</td>
<td>1118.29</td>
</tr>
<tr>
<td>1987-88</td>
<td>416.90</td>
<td>479.58</td>
<td>285.29</td>
<td>1337.55</td>
</tr>
<tr>
<td>1988-89</td>
<td>293.84</td>
<td>617.48</td>
<td>196.91</td>
<td>1257.59</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1609.88</strong></td>
<td><strong>2994.61</strong></td>
<td><strong>822.45</strong></td>
<td><strong>6147.25</strong></td>
</tr>
</tbody>
</table>

Source: Annual Reports of the sample companies.

Table 4.2 reveals that out of total outflow of foreign currency maximum amount has been paid through royalty followed by dividend, technical fees and commission. During 1980’s payment in the form of royalty to foreign technicians has shown an increasing trend as its value went up from Rs. 220.79 lakhs in 1982-83 to Rs 617.48 lakhs in 1988-89 except for a meagre decline in the year 1987-88. Payment in the form of dividend was Rs 279.49 lakhs in 1982-83 declined
to Rs 17.82 lakhs in 1984-85, the lowest during the period under review, again went up to Rs. 416.90 lakhs in 1987-88 and further declined to Rs 293.84 lakhs in 1988-89. Payment in the form of technical fees and commission have shown an upward trend except for the year 1984-85 and 1988-89. Maximum technical fees and commission was paid in the year 1987-88 as its value went up from Rs 23.79 lakhs in 1982-83 to Rs 155.78 lakhs in 1988-89 respectively.

Direct cost of technology transfer in proportion to total sales turnover, total remittances and exports has been depicted in the Table 4.3. It is clear from this table that the percentage of direct cost in proportion to total sales turnover has remained below one percent during the period under review. Percentage of direct cost to total remittances ranged between 5 to 11 percent whereas the percentage of direct cost to total exports ranged between 8 to 25 percent. Thus it can be concluded that direct cost of technology transfer in proportion to total sales is very nominal and in proportion to remittances and exports is not high.

The indirect cost includes restrictive business practices inserted in the technology transfer agreements by the technology suppliers. This limits the independence of the recipients in their decision making. Regulatory clauses inserted in the technology transfer agreements generally includes (i) control on sources of supply by technology supplier. Subrahmanian(9) (1972) found that out of 130
<table>
<thead>
<tr>
<th>YEAR</th>
<th>TOTAL SALES (Rs. in lakhs)</th>
<th>TOTAL REMITTANCES (Rs. in lakhs)</th>
<th>EXPORTS (Rs. in lakhs)</th>
<th>%AGE OF DIRECT COST TO TOTAL SALES</th>
<th>%AGE OF DIRECT COST TO REMITTANCES</th>
<th>%AGE OF DIRECT COST TO TOTAL EXPORTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982-83</td>
<td>142583</td>
<td>6788</td>
<td>2110</td>
<td>0.37</td>
<td>7.8</td>
<td>25</td>
</tr>
<tr>
<td>1983-84</td>
<td>151486</td>
<td>7984</td>
<td>4100</td>
<td>0.39</td>
<td>7.5</td>
<td>15</td>
</tr>
<tr>
<td>1984-85</td>
<td>172752</td>
<td>9171</td>
<td>4891</td>
<td>0.31</td>
<td>5.9</td>
<td>11</td>
</tr>
<tr>
<td>1985-86</td>
<td>198728</td>
<td>11591</td>
<td>5580</td>
<td>0.39</td>
<td>6.6</td>
<td>14</td>
</tr>
<tr>
<td>1986-87</td>
<td>212818</td>
<td>10469</td>
<td>7540</td>
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<td>15321</td>
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</table>

Source: Annual Reports of companies concerned.
collaboration agreements studied 41 had clauses restricting the purchase of materials. In most of the cases, the clauses made it obligatory on the part of local party to purchase raw material, components etc. from the technology supplier. The RBI(1968;1974) surveys also show that a significant number of regulatory clauses present in the foreign collaborations restricted the sources of supply of raw material and capital goods. Subrahmanian(1972) also found that when technology is imported through Foreign Direct Investment (FDI), the dependence on imported raw material is higher than in case of technology obtained under licensing. But while discussing with Technical Managers, Senior Managers of various tyre companies, it has been found that this restriction is not applicable on tyre companies. (ii) Substantial proportion of agreements contain clauses barring any change in the design and original specification provided by the technology suppliers. Second clause is also not applicable on tyre companies. (iii) The RBI surveys(1968;74) indicate that the bulk of the regulatory clauses present in the collaboration agreements regarding exports were either banning exports to some or all countries or requiring foreign collaborators permission for exports. This restriction is more applicable on tyre companies for radial tyres rather than on bias ply tyres. Foreign collaborators ban export to such countries where they have established plants or where they have marketing set up. (iv) Foreign collaborators do not impose any restriction on the expansion of product capacity so far
as tyre companies are concerned (v) They do not impose restriction that internal sales be routed through distributors specified by them. (vi) Foreign brand name along with local names for internal sales can also be used with their consent. (vii) Further, Indian tyre company can not sub-license technology to another company without their permission. In a nutshell, majority of the above mentioned restrictions are not applicable on tyre companies.

**ADAPTATION AND ABSORPTION OF TECHNOLOGY:**

The adaptation and absorption of technology has assumed significant importance in the post independence India. It is essential in context of our goal to attain technological self reliance and save foreign exchange. The Technology Absorption and Adaptation Scheme (TAAS) of the Department of Scientific and Industrial Research (DSIR) also aims to support and promote measures towards absorption of imported technology. The process of absorption and adaptation is a continuous process which involves the company's and collaborators team to work hand in hand along with the technical service team so that the product performance is kept well under control in a competitive situation. Foreign collaborators give necessary feedback data and assistance regarding the market as well as the product suiting to that particular application. It has been observed that in a number of new projects the tyre designs as furnished by the principal overseas collaborator have not been totally accepted in the Indian market. Thus the companies have found it absolutely essential to change,
in certain circumstances, the design of tyres and even the structure configurations of tyres to suit the Indian road conditions. Hence the unpacking of imported technology is a continuous feature which calls for special emphasis. It has been possible for some tyre companies in India to set up In-House Research and Development (R&D) Centres. Though it may be appreciated that these R&D units have contributed a lot in absorbing and adapting the imported technology yet it is inadequate in some respect. Government in 1973 introduced the scheme of granting recognition to R&D units in the industry. At present there are eight In-House Research and Development units from tyres and tubes industry. A brief account of R&D objectives, achievements, ongoing programmes and future plan of action of these units is presented below. (10):

1) Dunlop India Ltd:-

The R&D activities of the firm started as early as in 1960. At present there are three R&D centres of the firm located at Sahaganj in West Bengal, Ambattur in Tamil Nadu and Rubber Research Laboratory in Cochin. Each R&D centre is housed in a separate building.

Objectives of R&D Programme:- The main objectives of the R&D programmes are:-

- to develop indigenous technology in respect of product design, plant and equipment designs, raw materials, manufacturing methods, testing and evaluation techniques
to achieve technological self-reliance
-to create the ability to face international competition
-to provide technical know how to new units
-to develop programme for energy conservation

**R&D Achievements:** The details of the R&D achievements are given below:

- evaluation of performance of imported radial truck and tractor tyres
- development of bogie wheels for T.54 Tank Tyres for defence
- development of high performance white sidewall and vaneer strip compounds for passenger car tyres
- process development for increased yield of nylon during heat stretching
- design and development of truck and motor tyre machines.

**Specific Areas In Which R&D Carried Out By The Company:** The Company has successfully carried out research and development in the field of PUC belting, new range of steel cord. Manufacturing of tyres for use both in civil and military aircrafts, truck tyres for US markets and domestic Original Equipment (OE) manufacturers are in various stages of commercial production. This would help in saving of precious foreign exchange, improvement in tread mileage, and improvement in productivity.
On Going Programmes:— The company is also concentrating on the on-going programmes in the field of energy conservation, in tyre moulding, design and development, import substitution, waste recycling and product/process development etc.

Future Plan Of Action:— Development of new products, improving efficiency, indigenization of raw materials for steel cord belting, development of tubeless truck tyres for export market, development of fibre glass belted radial car tyres etc.

(2) Modi Rubber Ltd:—

The firm has established a full-fledged R&D centre at Modipuram and is recognized by DSIR. The R&D is housed in a separate building and separate accounts are maintained for it.

Objectives Of R&D Programme:— Some of the objectives of the R&D programmes include:

- to achieve self reliance in tyre technology
- to minimise product cost and waste and to assist in developing ancillary units etc.
- to achieve maximum degree of import substitution
- to conserve energy.

R&D Achievements:— With the setting up of R&D Centre in 1977, the company has been able to develop successfully passenger nylon car tyres of various sizes for imported and Indian cars. The major R&D Projects accomplished in the past include:
- development of high loading capacity truck tyres, tractor tyres of different sizes
- tyre with greater fuel economy
- partial replacement of carbon black with silica and other rubber compound
- modification in manufacturing process to save energy
- improvement in the life of tyres

**Specific Areas In Which R&D Carried Out by The Company:**
- adoption of anti pollution method
- development of import substitution
- enlarging the range of tyres for domestic and foreign market
- improving on quality, productivity and energy conservation technology with latest equipment
- interaction with local and international institution with a view to utilize the latest technology in manufacturing process

The result of these R&D have been very salutary and the company has been able to compete successfully in the domestic and foreign market, save precious foreign exchange by way of developing substitution for imported raw materials, ensure fuel efficiency, save in the cost of production and exploring new markets for its wide range of products having application in mining, tractors and trailers etc.

**On Going Programmes:** Major ongoing programme include the
development of Car, Scooter and tractor tyres of different sizes.

**Future Programmes:** The future programmes visualizes:-

- range development of light weight and tubeless tyres for automobiles
- exhaustive use of computer aided engineering process
- improving laboratory facilities for testing equipments and chemicals
- developing techniques for detecting flaws during manufacturing process

**Bombay Tyres International Ltd:**

The firm has its R&D Centre at Hay Bunder Road, Bombay duly recognized by DSIR

**Objectives Of R & D Programme:** R & D activities are pursued with a view to achieve the following objectives:-

- achieve maximum degree of import substitution
- minimize product cost, wastage, improvement in retreading industry and ensuring quality.
- development of new tyre design with a view to attain fuel economy
- assess and develop encillary units

**R&D Achievements:** Since the inception of R&D Centre the company has made efforts towards modernization, and indignization of many imported items. The company has the following achievements to its credit during the past few years:-
- development of new designs for defence tyres
- increased ply rating of rear tractor tyre sizes
- reduced ply construction of HD tyre sizes
- development of new butyl air bag single piece construction

Specific Areas In Which R&D Carried Out By The Company:— It pertains to :-
- the introduction of new indigenous raw material
- introduction of new technology pertaining to the use of nylon
- development of new tyre design and minimisation of product cost

As a result of above, new pattern and sizes were added to the existing production to meet the strict requirement of automobile industry. New and cheaper raw materials are being used and their sources are being developed. New product range were suitably modified as per international requirement and this helped the company to substantially export its products.

Future Plan Of Action:— Future plan of action includes:-
- development of new methods of testing
- development of improved tyres and tubes compounds
- revised construction of existing sizes for exports
- development of new design of tyres for trucks

(4) Ceat Tyre (India) Ltd. :-
The company has its R&D Centre at Bhandup, Bombay. It is recognized by DSIR since 1984, though developmental work started as early as 1974 with separate R&D facilities and personnel. In the initial phases, the main objectives of R&D programme was to adapt technical know-how supplied by their collaborator to suit the local conditions and requirements.

**R&D Achievements:** - The company has carried out R&D in the sphere of product design, import substitution and production technology. During this period, the company has the following achievements:

- development of new sizes of tyres for two wheelers and other vehicles such as Maruti Car, Van, Jeep, Premier, Allwyn Nissan and for export market.
- improvement in tyre flaps quality.
- development of more wear resistance compound for truck tyres.
- development of Motorcycle tyres specifically for Hero Honda, Ind. Suzuki and Escorts Yamaha.
- improvement in the friction resistance of passenger tyres.

**Specific Areas In Which R&D Carried out by The Company** - It relates to:

- development of new products for domestic and foreign market.
- import substitution with a view to save foreign exchange.

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- process/equipment development for upgrading technology.
- use of alternative materials like fibre glass for manufacturing tyres.

As a result of above R&D there has been marked improvement in fuel economy, increased road mileage, series of new products were developed for use in the new generation of vehicles after exhaustive trials, product range for export market was also improved. Import substitution have been developed in respect of tyres used in the mines and passenger radial tyres with textile belt were also introduced successfully.

**On Going Programmes:** The company's major R & D programmes are directed towards:
- development of new tractor tyres of different sizes.
- radial tyres for Premier Padmini and Ambassador, etc.

**Future Plan of Action:** Future programme relates to the production of:
- radial tyres for Telco, Hindustan Motors, Maruti, Ashoka leyland and Honda group of companies.
- tubeless tyres.
- development of new tread pattern.
- introduction of nylon motor cycle tyres.
- process improvement in chemical compound.
- import substitution and cost reduction in manufacturing process.

(5) MRF Ltd: The firm has established its R&D Centre at Tiruvotriyur Madras.

Objectives of R&D Programme: - The objectives are producing compounds for specialized uses like tank tyres, mining tyres, radial and belted tyres, development of product and design to suit Indian road conditions with emphasis on safety. It also aims at absorption and adaptation of imported technology.

Research And Development Achievements: - The company has achieved great success in absorption and adaptation of foreign technology and has been able to develop new product/process and to effect improvement in existing product/process, import substitution, cost saving etc. Major R&D achievements in the past include:

- development of Moped tyres, light truck tyres, Radial tractor tyres.
- development of glass belted passenger tyres.
- precured tread for retreading.
- development of valcanising solution for better safety.
- development of special type of paints for overcoming cracking.
- development of new sources for carbon black.
- development of indigenous rayon source to meet
international standards.

**Specific Areas In Which R&D Carried Out by The Company:**

- new product/Process development.
- improvement in existing production.
- import substitution.

As a result of above R&D the company has been able to improve the quality of tyres keeping in view the Indian road conditions, overloading of vehicles. The result of such improvement is being reviewed periodically in the light of performance of tyres and necessary modifications are made as and when required. It has also been able to produce aircraft tyres, OTR giants tyres, high performance racing tyres used in car rally and radial tyres etc. R&D also monitor that tyres are produced according to the strict prescribed standards. Research has also been done to replace imported raw materials by indigenous ones.

**Ongoing Programmes:**

R&D projects of the firm in progress include steel belted radial truck tyres, study of rubber compounds used in manufacturing of tyres, automatically cutting of treads.

**Future Plan of Action:**

Some of the major future projects aim at:

- keeping abreast of latest development in technology and in self reliance in technology.
- active participation with Bureau of Indian Standards (BIS) for preparation of standards.
- development of substitute for imported materials.
- closer involvement with OE manufacturers to develop products according to their requirements.
- take up giant research projects with testing laboratory and university.

(6) **Apollo Tyres:**

The company established its R&D department at its plant, Perambra (Kerala) in 1976 with a well equipped laboratory and testing centre.

**R&D Achievements:** Past research and development achievements of the company include:

- development of radial passenger car tyres of different sizes suitable for Indian road conditions.
- developing the process of fibre glass for use in radial tyre belts.
- development of new tyre designs for passenger as well as truck tyres.
- substituting imported raw materials with indigenous ones and embarking upon a large number of cost reduction programme such as reduction of antioxidants in compounds.
- improvement in energy conservation programmes resulting in efficiency of boiler and steam distribution.
Specific Areas In Which R&D Carried Out By The Company: R&D centre is currently engaged in the activity of new product/process improvement, import substitution along with technology absorption and adaptation.

As a result of above the company has been able to cater to the latest requirements of market and improvements in existing products have also been made. The product range has also been expanded for the local and foreign market. It has also resulted in import substitution and saving of foreign exchange.

On Going Programmes: Some of the major on-going programmes include:

- modification and optimum use of antioxidants in tyre compounds.
- development of local source for tyre building machines.
- development of different series of radial passenger car tyres and tubes, radial light truck tyres and tubes.

Future Programme: Some of the major R&D programme proposed during the next three years are:

- development of new series of truck tyres suitable for Indian road conditions.
- import substitution of raw material/equipment.
- process modification in improving treading of tyres.
Vikrant Tyres Limited:
The R & D activity of the company at Melagalli, Mysore is housed in a separate building. The R & D units is recognized by Department of Scientific and Industrial Research.

R & D Achievements: The R & D Centre has made the following achievements:

- development of radial tyre building Machine etc.
- development of new moulds design to replace imported moulds and specification
- development of radials 100 R 20 size

Specific Areas in which R & D Carried out by the Company:

It includes

- development of new moulds and processes for radial and conventional tyres
- development of equipments for new plants
- new product development for domestic and export market

As a result of above, significant improvement has been made by the company in the performance of the existing range of products, the new patterns in radial truck tyres, new patterns in passenger and light truck range were launched successfully to meet the market needs.

Ongoing programmes: Following R & D programmes are in progress:

- development of new sizes of tyres for export
- more intensive study in usage of special
ingredients such as silica
- use of processing aids for better dispersion of natural rubber, polybutadien and carbon black

**Future Programmes:** Some of the R & D programme for future are:

- intensive manufacturing and marketing of radial truck tyres for local export market
- development of tubeless and low profiled radial tyres basically for export
- Promoting more precured retreading units by providing materials, machinery and technology with special emphasis on radial tyre retreading and repairs.

(8) **J.K. Industries Ltd:**

The R&D activity of the firm started right from inception of the plant. The company has a full time Manager, Incharge of R&D activities at its plant at Kankroli in Distt. Udaipur (Rajasthan). This centre has been recognized by DSIR.

**Objectives of R&D Programmes:** The R&D programme has been drawn up with a view to achieve:

- self-reliance in tyre technology.
- development of new tyre concept i.e development of puncture proof tyres.
- development of new processes for improved product life and cost reduction.
- development of all steel radial tyres.
- import substitution and replacement of expensive or scarce materials.
- energy conservation in tyre manufacturing process.
- waste recovery and proper use thereof.

R&D Achievements: R&D achievements include:
- development of steel belted and radial tyres for passenger cars, trucks/buses and three wheelers.
- development of heavy and light tyres for use in heavy and light commercial vehicles.
- development of new tread pattern to suit Indian road conditions.
- development of new tyres compounds giving more mileage and longer life.
- development of new patterns/tyre for export market.

Specific Areas In Which R&D Carried Out By The Company: It includes:
- improvement of existing products and processes.
- adaptation of imported foreign technology.
- import substitution.
- cost reduction methods.
- development of testing and evaluation system for raw material and final products.
- absorption and adaptation of latest technology.

As a result of above wide range and sizes of tyres for
buses, trucks and light commercial vehicles, both for domestic and foreign market have been developed. Import substitution of costlier raw material, product improvements have been effected in the existing range of tyres considering changing load pattern and road conditions, radial tyres have been introduced for passenger and LCV which has resulted in better road grip so as to reduce road accidents and give more road mileage.

**On-Going Programmes:** Some of the R&D projects pertain to:

- waste tyre recycling.
- optimization of tyre cure process.
- development of tubeless tyres which are used extensively in the foreign market.

**Future Programmes:** The future programme includes:

- development of new antioxidants for developing newer and better materials.
- developing alternate source for supply of rubber.
- development of tyre reinforcing materials to develop tyres to meet severe service conditions.
- strengthening of R&D facilities to keep pace with the latest development in tyre technology, adaptation, and achieving self reliance.
- developing better co-ordination with OE manufacturers to meet their demands.
- increased participation in joint research
projects with National University and Technical Institutes like Bureau of Indian Standards for preparation of standards.

Hence, it is evident from the R&D achievements of various units that though the industry has been able to absorb and adapt the imported technology to a great extent. Yet it has not been fully absorbed. It is a continuous and unending process not only in India but also in most advanced countries of the world and as such it is essential that the company should have access to its collaborators for upgrading technology and to keep abreast with the latest innovations and developments taking place all over the world to meet the ever changing needs of the market. Indian tyre industry is dependent in the matter of applied technology due to inadequate testing facilities in the country. Any change in the specifications of materials, modifications in the composition of the mix or any dimensional variations are all generally referred to the collaborators for their information. Gaps in the following components of tyre technology still exist:

(i) **Technology Related To Raw Materials:** Like rubber and rubber chemicals, rubber compounding and vulcanisation. The rate of development of new polymer, strengthening material and rubber chemical is abysmally low in India.

(ii) **Engineering of Tyre Design:** Pattern design gap exist in
this area.

(iii) **Manufacturing Technology:** Large gap exists in machinery/plant upgradation and automation in terms of consistency, productivity, energy input and waste.

(iv) **Quality Control Technique:** Quality control practices in Indian tyre industry are manual and thus man dependent. Quality assurance through mechanization and instrumentation is inadequate in India.

(v) **Application Engineering:** There exists wide gap in vehicle tyre road interaction and safety on road.

**TECHNOLOGICAL CAPABILITIES OF TYRE INDUSTRY:**

Technological capabilities are reflected in basic design and engineering of plant, detailed engineering and civil construction of plant, operation of plant and technical knowledge required for the end product. If the country is capable of imbibing all these processes then it will be self sufficient in the matter of manufacturing products indigenously. But in respect of tyre industry, it is dependent upon foreign collaborators from the initial stage of plant layout to the end product. After the completion of civil work, operation of plant is also carried out by them. They alongwith Indian colleagues carry out necessary tests from initial stage to the end product. They also provide necessary technical staff for the training of Indian workers.

Till to-date, none of the Indian tyre companies has been able to indigenise the basic technology for the
manufacture of tyres. It is estimated that major portion of
time and money of In-House R&D centres is spent on adopting
foreign technology. With the result very little time is left
for basic research which is expensive as well as time
consuming. This basic technology can be divided into two
parts(11): first by way of manufacturing technology requiring
an understanding of the qualities and properties of the
different types of material that are used in the
manufacturing process of making tyres, their inter-action,
the optimum proportions in which these materials have to be
blended, the process parameters including control on
temperature, pressure, other operating conditions and of the
equipments that are used in the process. The second element
of the basic technology is the engineering of tyres with
appropriate design parameters which should give optimum
mileage on Indian road, climatic conditions as well as
overloading of capacity. These two elements of the basic
technology are inter-connected. The design of the tyre has to
take into consideration various inputs which are necessary
for the manufacture of tyres. At present there is no
Institute in India for the development of basic technology to
manufacture tyres.

Fig. No. 4.2 depicts the comparative tyre technology
ladder which highlights the technological advancements so far
made by Indian and world tyre industry. Stepwise details of
tyre technology ladder is as follows (12):
INDIAN TYRE INDUSTRY
MOVING TOWARDS HI-TECH SOPHISTICATION

FIG. 4.2

- Radial Construction - All Steel (Trucks)
- Tubeless - Radial Construction (Truck & Passenger)
- Radial (Construction) - Textile/Aramid Belt (Trucks)
- Radial Construction - Textile/Textile Belt (Passenger)
- Radial Construction - Textile/Glass Fibre Belt (Passenger)
- Radial Construction - Textile/Textile Belt (Rayon/Nylon/Polyester) Passenger
- Radial Construction - Textile/Textile Belt (Nylon) Carcass (Truck & Passenger)
- Rayon (reinforcement) Carcass (Truck & Passenger)
- Cotton (reinforcement) Carcass (Truck & Passenger)
- Fuel Economy/ Low rolling resistance
  Special Compound (Track)
- Run Flat (Puncture Proof) Passenger - Denova
- Run Flat (Puncture Proof) Passenger - New Concept
- Low Aspect Ratio - Radial Construction (Trucks)
- Bias (Cross Ply) Belted - Textile/Textile Belt (Truck & Passenger)
- Tubeless (Cross Ply or Bias) (Trucks & Passengers)
- High Aspect Ratio - Radial Construction (Tracks & Passengers)

THE INDIAN TYRE INDUSTRY HAS TO REACH OUT TO

STEPS CLIMBED BY INDIAN TYRE INDUSTRY

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(1) **Tyre With Cotton (reinforcement) Carcass:** At the first stage of tyre development ladder the concept of bias or cross ply tyre was based on cotton carcass main reinforcing material available at that time (end of 19th and early 20th century). Cotton reinforcing material has inherent problem of low strength and high moisture absorbance. Obviously large number of plies were needed to get the reinforcement strength for the tyre resulting in higher weight of the tyre.

(ii) **Tyre With Rayon (reinforcement Carcass):** With the development of viscose and rayon the strength of reinforcing material went up and this found application in tyres during early 20th century. Due to higher strength of rayon it was possible to reduce number of plies and the weight of the tyre.

(iii) **Tyre With Nylon (reinforcement) Carcass:** With the development and introduction of nylon the strength of reinforcing material went up substantially resulting in further reduction of number of plies and the weight of the tyres. Also the heat and impact resistance of the carcass improved resulting in better tyre performance and longer life as well as better retreadability.

(iv) **Radial (construction) Tyre-Textile/Textile belt (Rayon/nylon/polyester):** By the middle of the century a new concept in the construction of tyre viz. radial tyres was introduced. These tyres have better performance, more mileage, fuel efficiency and high speed. Initially these
radial tyres were based on textile carcass made of rayon/nylon/polyester) and textile belt.

(v) **Radial (construction) Tyre-Textile:** With the development of inextensible steel cord, it was introduced for belt purpose with textile carcass.

(vi) **Radial (construction) Tyre-Textile/Glass Fibre belt:** With the introduction of glass fibre, it was found more suitable to use it for belt purpose in radial tyres with textile carcass.

(vii) **Bias (cross Ply) Belted Tyre-Textile/Textile Belt:** The concept of belt from radial construction bias belted tyres was introduced in cross ply construction having textile belt, primarily in U.S.A. in the second half of century. But it was not found to be viable there. So in India, gaining from the experience of developed countries this step was omitted which otherwise would have resulted in unnecessary spending of time and money for development.

(viii) **Low Aspect Ratio (Cross Ply or Bias) Tyre:** In respect of higher speed and better performance of tyres, a new concept of low aspect ratio in cross ply construction (Ratio between section height and section width of tyre) was introduced successfully in India and India is presently at this stage of the technology ladder.

(ix) **Tubeless Tyres (Cross Ply or Bias):** The concept of
tubeless tyres in cross ply construction was introduced obviating the use of tubes and avoiding puncture/replacing of tubes. It does not have application in India and is produced only for specific market requirement.

(x) **Radial (construction) Tyre—All Steel:** In this case both carcass and belt material are made of steel cord and such tyres have become very popular in developed countries.

(xi) **Radial (Construction) Tyre—Textile/Aramid Belt:** With the discovery of new synthetic fabric namely aramid which has very high strength and very low elongation, radial tyres with textile carcass and aramid belt have been introduced on experimental basis.

(xii) **Tubeless Tyre—Radial Construction:** The concept of tubeless tyre has also been extended to radial construction and has been found very popular and good in performance.

(xiii) **Low Aspect Ratio—Radial (construction) Tyre:** After gaining the experience of low aspect ratio from cross ply construction, this aspect has been introduced in radial construction also.

(xiv) **Run Flat (Puncture Proof) Tyre—Denova:** For long technicians were engaged in finding tyres which could withstand puncture and run at least for certain period. Such type of puncture proof tyre (Denova) was introduced by Dunlop in 1960s. This however did not find commercial success.
Run Flat (puncture proof) Tyre-New Concept: A new concept of run flat tyre (puncture proof) was introduced by Continental wherein the basic construction of the rim and bead was changed by which on loosing air the tyre tread sits on the rim thus enabling one to drive at a reasonable speed for a long distance till he can attend to the flat tyre.

Fuel Economy/Low Rolling Resistance Tyre-special Compound: A tremendous work is being carried out towards the development of tyres with modified special compound besides tyre construction aspect, to reduce rolling resistance thus gaining in fuel consumption. Already certain tyres of this concept are in the market showing encouraging results.

From the foregoing discussion it is clear that India is presently at Low Aspect Ratio (cross ply or bias) tyres stage. Where as in the advanced countries fuel efficient and puncture proof tyres are being used. India is yet to make great leeway in this direction before it can compete in the global market. The tyre industry in India has attempted to keep abreast of the progress made elsewhere in the world.

Initially, the cotton fabric was used as a reinforcing material in the manufacture of tyres. During 60’s the industry switched over to the use of rylon fabric as cotton was not found suitable and durable. During 70’s the nylon fabric was in vogue because it was not only light but also more durable and strong than rayon cord. Due to growing shortage of natural rubber in India and of the difficulty in
importing the same from abroad, due to foreign exchange crisis, there is a growing use of synthetic rubber in tyre manufacture. The industry is also using various types of rubber chemicals like improved carbon black to achieve higher durability and better performance of tyres. Generally most of the production of tyre in India is based on cross ply process. Now a beginning has been made to switch over to radial car tyres. Some of the tyre companies have also started making radial truck tyres, but much ground has yet to be covered before such tyres can be successfully adopted on a large scale.

Research and development (R&D) expenditure is a barometer of industries commitment for upgrading its technology. Table 4.4 shows the amount of R&D expenditure incurred by ten tyre companies individually and its percentage in proportion to sales for the year 1988-89. Due to the nondisclosure of R&D expenditure in the companies balance sheets and further due to the nonavailability of this information from the individual companies, this expenditure in proportion to sales has been depicted for one year. This table reveals that the share of industrial R&D expenditure in Indian tyre industry is very nominal. The present expenditure on R&D by individual tyre units needs to be stepped up. Various researches also like the one conducted by Surender Kumar of Delhi University on three petrochemical manufacturing firms and seven drugs manufacturing firms indicate that expenditure on R&D is comparatively less more
particularly when the control is in the hand of foreign equity holding companies than in case of non foreign equity holding companies. Since we have data on R&D expenditure incurred by different tyre companies for only one year it is not possible to conclusively prove the claims of other researches for the tyre industry particularly in the absence of trends. Further the technological potentialities the industry has thus generated are reflected in the growing stock of technical manpower, an important factor assuring assimilation of imported technology. The percentage of manpower employed for R&D over total manpower varied between less than one percent to about five percent in different tyre companies during 1983-86 which is highly inadequate.

Thus the technological capabilities of Indian tyre industry reveals that R&D units of tyre companies are concentrating on adaptation and absorption of imported technology and this process is also very slow compared to developed countries but good compared to developing countries. More than 30 years time has been taken for adaptation.

**Continued Dependence on Foreign Technology:**

Tyre industry is dependent on foreign collaborators from the stage of plant layout to the end product. Due to the continued technical collaboration the consumer in particular and the nation in general has been benefitted a lot. Such benefits include increased mileage of tyres, reduction in
tyre failures, increased load carrying capacity, acceptance

Table 4.4

RATIO OF R & D EXPENDITURE TO ANNUAL TURNOVER OF TYRE
COMPANIES FOR THE YEAR 1988-89

(Rs. in lakhs)

<table>
<thead>
<tr>
<th>Company</th>
<th>Annual Turnover</th>
<th>R &amp; D Expenditure</th>
<th>% of R&amp;D Exp. on Turnover</th>
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<td>Dunlop</td>
<td>N / A</td>
<td>N / A</td>
<td></td>
</tr>
<tr>
<td>Ceat</td>
<td>41,023</td>
<td>56.96</td>
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<td>Goodyear</td>
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<td>90.00</td>
<td>0.41</td>
</tr>
<tr>
<td>MRF</td>
<td>49,498 **</td>
<td>373.57 **</td>
<td>0.75</td>
</tr>
<tr>
<td>JK</td>
<td>27,853</td>
<td>92.97</td>
<td>0.33</td>
</tr>
<tr>
<td>Vikrant</td>
<td>20,055</td>
<td>26.61</td>
<td>0.13</td>
</tr>
<tr>
<td>Premier</td>
<td>9,114 **</td>
<td>4.80 **</td>
<td>0.05</td>
</tr>
<tr>
<td>Apollo</td>
<td>17,820</td>
<td>100.33</td>
<td>0.56</td>
</tr>
<tr>
<td>B.T.I.L.</td>
<td>14,372 *</td>
<td>28.94 *</td>
<td>0.20</td>
</tr>
<tr>
<td>Modi Rubber</td>
<td>8,388 ***</td>
<td>7.86 ***</td>
<td>0.09</td>
</tr>
</tbody>
</table>

Note: * Adjusted to twelve months from original 17 months.
** Adjusted to twelve months from original 18 months.
*** Converted to 12 months from original 11 months.
Source: Annual Reports of the respective companies.

of Indian tyres in sophisticated markets, productivity improvement, energy conservation and providing training to
the tyre companies personnel. All the above valuable achievements have been possible at a very nominal foreign exchange outflow (by way of royalty payment) at an average of around Rs. 4 crores per annum. This amount is very nominal of the total amount required for undertaking the underlying research. The complete gamut of basic research involves colossal expenditure which is beyond the capacity of Indian tyre companies. Goodyear, of U.S.A., is alone spending around Rs 300 crores per annum on research. Even in the world scene giant transnational companies have been joining hands to do research because of the huge resources required. For example earlier Dunlop and Pirelli had worked together in research, followed by Goodrich and Uniroyal. Goodrich and Uniroyal have since merged. Goodrich and Yokohama are presently engaged in research jointly. Lastly Continental, West Germany is doing research alongwith Toyo of Japan and General Tire of USA. Even in the case of these companies basic research and applied research go together in the sense that fruits of basic research of one company are taken advantage of by other companies. Similarly, excepting for a few giant tyre companies all other companies in the world have largely been concentrating on applied research. When Indian tyre companies enjoy the fruits of such mega investments made by multinational giants in the R & D and that too for such a small payment, continuous dependence on foreign collaborators is inevitable and certainly appears to be advantageous and logical.
Further the tyre technology ladder depicts that Indian tyre industry has to go a long way in technology advancement, given the technology status on the global scene. Therefore, continuing foreign technical collaboration in respect of cross ply tyres is essential. This tyre technology is continuously undergoing a dynamic innovations in the world market. Indian tyre market also enjoys protection on account of heavy import duty, therefore competitive element is weakened and there is no incentive for R & D with a view to upgrade technology. Due to all these reasons tyre companies are dependent on foreign collaborators for such a long period of time.

**FUTURE GUIDELINES FOR TECHNOLOGY TRANSFER**

Tyre manufacturing is a highly complex process. There has been a very substantial all round improvement in the indigenous tyre quality, essentially due to the availability, unpacking and suitable assimilation through in-house R & D efforts, of the latest foreign technology for tyre manufacturing. Ultimate benefits of this have been to the consumer as well as to the nation. Tyre technology is undergoing dynamic and continuous advancement. Moreover the research necessary to produce such advancement is exorbitantly costly and definitely out of the reach of Indian tyre companies. In this connection the Satyapal Committee (1985,1988) which was appointed to review the
The technological status of the Automobile Tyres and Tubes Industry has made the following recommendations:

(a) In order that industry is technologically brought up to international standards, it is necessary that the old units be modernised as quickly as possible. Taking into account the high cost of modernisation at current prices, it will be necessary to consider fiscal incentives for expansion of existing units including modernisation on lines comparable to the incentives that are extended for the establishment of new units in the industry.

(b) In addition to such modernisation, it will also be necessary, given the current status of the meagre R&D efforts and capabilities within the Indian industry to have access to foreign technology on a continuous basis in order to take advantage of improvements in technology until such times as R&D capabilities within the industry are established on a reasonable scale. Otherwise knowledge of new materials and machines will stagnate, opportunities for improvements, innovations and economies will be missed, development will slow down and exports will suffer. (c) An optimal solution to the present situation will not, therefore, be to totally cut off the flow of foreign technology but to adopt a two-fold strategy combining enlarged R&D efforts within the country on an adequate scale with a declining level of external dependence in basic and applied technology.

(c) A Central Research Institute should be established
for undertaking research development in automobile tyre industry commensurate with the large size of the industry. The establishment of this institute should be undertaken as the central responsibility and be organised by the Central Government. The industry should however, be very closely associated in the planning and implementation of the research institute. It should be partially funded by the industry through a cess to be imposed on the turnover of the industry. To the cess so collected Government should provide an equal contribution.

(d) The institute should also provide for comprehensive testing facilities which are adequate not only for its own R&D activities but also available on demand to the undertakings within the industry.

(e) The committee feels that early measures should be taken to speed up the pace of introduction of radial tyres within the country on account of significant advantages from this improved variety of tyres to the economy.

(f) Since crossply tyres will dominate the Indian scene at least for some more time, while advanced countries have switched over to maximum radial tyre production, it would be obvious that the technical knowhow assistance from foreign collaborators to the manufacturing units will be beneficial for implementing a phased programme in the manufacture of radial tyre.

(g) Since the vehicle industry is in the process of
undertaking a major technological breakthrough due to establishment of new types of vehicles through mainly Japanese technological knowhow etc. the establishment of certain special functional tests for tyres has become an absolute necessity keeping in view the sole objective of constant search for better tyres. As a result, the automobile tyre industry should aim at constant development of more durable tyres to meet the demand for great driving safety and fuel economy. This should be one of the prime objectives.

(h) In-house industrial R&D units could further step up R&D activities towards adaptation and absorption of imported technology.

(i) The tyre industry may strengthen their linkages with national laboratories and institutions for research inputs, which can not normally be carried out by them.

Mooted by the Satyapal's Committee, National Centre for Tyre Technology is being established at Bangalore and this Centre will start rolling from 1991. This centre will maintain strict tabs on the quality of raw materials both indigenous and imported with the help of which tyres are manufactured. samples sent from anywhere in the country will also be tested. This certainly is a welcome step and it is the time alone which will tell the achievements of this proposed centre. As the experience all over the world has revealed that it is difficult for even the Multinational Giants to carry out R&D activities individually considering the finances involved and they have now started pooling their
resources in this endeavour. The Indian companies would still find it more difficult to independently establish R & D cells in their organisations to carry out basic as well as applied research in the area of tyre technology. Hence, all out efforts should be made to ensure the success of National centre for Tyre Technology. Till this centre becomes fully functional and operationally successful, the Government has no option but to allow a continuing inflow of technology.
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